Manual of Traffic Studies for Marine Container Terminals

U.S. DEPARTMENT OF COMMERCE
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Office of Ports and Intermodal Systems

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MARITIME ADMINISTRATION

OFFICE OF PORTS AND INTERMODAL SYSTEMS

MANUAL
of
TRAFFIC STUDIES
for
MARINE CONTAINER TERMINALS

Submitted by

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FOREWORD

This manual of traffic studies for marine container terminals was prepared under the Government sponsorship of the Maritime Administration. The manual is intended as a guide for personnel concerned with traffic analysis of motor vehicles, including trucks and trailers, entering and leaving marine container terminals.

CONTENTS

1. INTRODUCTION

100. Background

In the surface transportation of goods, the most difficult and expensive operation occurs at the interface of land and sea transportation modes. The huge success of marine container shipments can be attributed to the efficiency obtained by consolidating cargo in standardized containers for common point destinations.

Trucking operations are a major part of this interface. Trucks may either deliver containers to their local or hinterland destination, providing the entire land transport, or they may be used for drayage between marine container terminals (MCT) and the railroad TOFC/COFC terminals where trailers and/or containers are transferred to or from railroad flat cars.

101. Responsibilities

Truck transport may be the responsibility of the steamship company, the railroad, the shipper, or the freight forwarder. In each case, however, the trucks use public roadways and are subject to traffic ordinances and devices. Whether roadways come under the jurisdiction of the port or not, the efficiency of the port operation will be influenced by the capacity and control of the access and connecting roadways serving the MCTs. An understanding of the traffic problems associated with these roadways and an appreciation of the impact of these problems on the efficient operations of the port can be obtained by various traffic analyses.

102. Purpose

This manual is intended as a guide for personnel of port authorities, terminal operators, and local government planning agencies concerned with traffic analysis of motor vehicles, including trucks and trailers, entering and leaving marine container terminals. This manual:

a. identifies the traffic problems associated with movements of containers into and out of marine container terminals.

b. indicates where traffic analyses would be useful in helping to solve these traffic problems.

c. defines the minimum information and data elements required in various traffic studies.

d. outlines in sufficient detail some of the more basic procedures, forms, and methods for conducting traffic analyses.

103. Scope and Limitations

This manual is designed to cover the major types of traffic problems associated with marine container terminals in port areas. In many cases, a port authority does not have sufficient resources to assign personnel to full-time traffic engineering responsibilities. Inasmuch as each terminal varies in size, shape, equipment, work practices, and system design, this manual is not concerned with traffic movements wholly within a terminal nor with container transfer problems associated with rail spurs and ramps inside the terminal. Where rail ramps are outside of the terminal area, they are considered as a major origin-destination (O-D) zone and so treated.

104. Measures of Effectiveness

Measures of effectiveness are bases for making comparisons. They are usually measurements related to some constant unit. Examples are:

- travel time
- containers per acre storage area
- trucks per lane per hour
- average speed
- accident frequency
- peak hour traffic

105. Standards or Warrants

Standards or warrants are measurements that have been adopted as standard. It is usually necessary to collect much information and data in order to establish such use criteria. Examples of standards are:

- signal and sign designs.

- road capacity criteria (e.g., National Academy of Sciences--"the capacity of a multi-lane highway under ideal conditions is considered to be 2,000 passenger vehicles per hour").

- 85 percentile speed--"Experience has shown that the 85th percentile speed is the one characteristic of traffic speeds most nearly conforming to a safe and reasonable limit."

For MCTs such criteria are largely nonexistent. Only by systematic collection and analysis of shipping tonnage in terms of container deliveries and pickups can such criteria be derived. This manual was prepared to promote such systematic data collection with an eye toward the eventual establishment of MCT traffic design criteria.

106. Definitions

Most of the terms used in this manual are easily understood in the context in which they are used. Certain traffic terms have precise meanings, however, and these are set forth in the Glossary at the end of this manual.

2. GENERAL APPLICATION OF TRAFFIC STUDIES TO MARINE CONTAINER TERMINALS

200. General Usefulness of Traffic Studies

Port areas containing marine container terminals experience many of the same traffic problems as larger metropolitan areas. The unique characteristics of port layouts and the nature of the automotive traffic entering or leaving container terminals lend themselves, however, to rather simple operational studies aimed at solving specific problems or providing means to assemble data that could be useful in establishing planning criteria.

201. General Description of Marine Container Terminals (MCT)

An MCT is a self-contained area of land alongside a waterway or basin containing berths at which all types of container vessels may dock, load, and unload container cargo. Whereas MCTs may vary in size, shape, equipment, system design and work practices, they all have certain functions that lend themselves to traffic analyses. In particular, each MCT has a "gate" or cordon with one or more entrances and exits that defines the limits of the terminal. In certain cases, the terminal may be divided into two areas in which external traffic comingles in between, such as the MCT that has a container freight station (CFS) located

elsewhere. Other functions that are common are:

- Customs and administration stops
- Special parking
- Inspection check center
- Weigh bridges
- Marshalling areas
- Load and unload equipment
- Movement equipment
- Ramps and roadways
- Berths
- Signals and communications

202. Types of Traffic Problems

In general, the most common traffic problems associated with the MCT may be included in these nine categories:

- Administrative or jurisdictional
- Facility planning
- Queueing at entrances of the MCT
- Access to MCT
- Parking and storage
- Signs
- Highway and road design
- Ship coordination
- Accidents

203. The Nature of Traffic Problems

Traffic problems concern both citizens and public officials. One problem, easily recognized, may appear only under "peak" situations; another may exist as a chronic deficiency without being noticed. In either case, the problem is real and the solution should be sought on the basis of facts and analysis and not on the basis of emotional complaints of citizens or opinionated views of public officials.

204. Uses of Traffic Studies and Frequency

Traffic studies associated with MCTs have in general two purposes. The first is to provide a base for action to remedy an unsatisfactory traffic situation. The second is to provide information on which to base traffic requirements for facility plans. Traffic studies are particularly valuable in checking the effectiveness of traffic engineering changes by a comparison of traffic behavior before and after the changes have been made. For example, traffic studies are used to measure the impact of substantial increase in shipping on traffic around MCTs.

205. Pitfalls of Traffic Studies to MCTs

Since traffic studies occasionally are costly in time and money, care should be taken to avoid oversimplified conclusions regarding cause and effect relationship and the development of trends. Common mistakes include:

- Study design not related to objective
- Failure to evaluate all data at disposal
- Failure to correctly interpret fluctuation in data such as seasonal, time of day, or chance variations
- Generalization on basis of averages or on basis of specific instances
- Spurious accuracy such as computation in which one of the figures is a guess or approximation

206. Planning Traffic Studies

Four essential characteristics of even the most simple traffic study are:

- Planning to be certain that the information and data will be relevant and useful for the purpose of the study.

- Personnel who are trained to do what is required to be done.
- Equipment for measurement and data collection (i.e., clipboards, stopwatches and more complex instruments and counters).
- Files that maintain information and data in useful form, for several years after the study.

Only by careful attention to these aspects can one obtain a study that will provide useful conclusions related to the purpose of the study.

207. Traffic Problems and Study Methods

Traffic problems associated with MCTs are related to other problems such as lack of adequate storage for containers and trailers within the terminal itself. Traffic studies are merely peripheral to this type of problem. For example, in considering the problem of storage, it may be important to the MCT operator whether he employs a 20 ft. container or a 35 ft. container. In traffic analysis, the difference in size or whether the container is full or empty is of little importance. Only the movement per se of the container is strictly relevant to traffic studies. But since effort would be expended in traffic count studies that could be correlated with other MCT operations, provision should be made in the forms and procedures to collect additional information simultaneously.

The nine different types of traffic problems usually encountered in a port that are associated with MCTs are discussed in the next section. The specific study methods employed in dealing with these problems are covered in the remainder of the manual.

3. TYPICAL MCT TRAFFIC PROBLEMS

300. Administrative and Jurisdictional

The development and maintenance of inventories of physical traffic facilities and controls and of the administrative records dealing with traffic are ready reference for any traffic engineering study. The location and adequacy of this information vary according to the organizational jurisdiction of the roadways involved. The purpose of an administrative study is to understand the chain of jurisdictional responsibility in traffic engineering functions.

Since the accomplishment of traffic studies may be delegated to different personnel within the port organization, it would be desirable to establish in writing the organizational chain of responsibility and the location of

administrative records for traffic matters. Regardless of whether a port has a traffic engineer on its staff or not, permanent data on traffic are needed, if for no other reason than to establish proper liaison with responsible authorities that are involved in the port area.

Most ports today do not have traffic engineers nor total responsibility for the highways, roads, or streets nearby or within the port area. In many cases, assistance may be obtained for traffic studies at little or no cost from the city, county, or state authorities responsible for traffic engineering in the area. It is important that the port authority understands that traffic problems do affect the efficiency of port operations and that an understanding of the multijurisdictional aspects of a traffic problem is part of the solution.

301. Facility Planning

As new facilities are built and existing facilities enlarged to accommodate the expansion of container transportation, traffic studies are required to determine whether the demands on the roads and access to new terminal areas may be satisfied by existing roads or whether new or wider roads are needed. The planning of a new facility and the enlargement of an existing facility entail considerable study, planning, and capital expenditure. In one case, traffic planning computations provided to the port by the terminal operator might underestimate the amount of traffic anticipated and parking space needed. This in turn could result in bottlenecks at terminal entrances and traffic jams along the approach. In another case, the port itself might miscalculate the amount of container traffic through a common user terminal creating delays for ships awaiting a berth and for trucks and tractors delivering and removing containers.

Traffic generation studies of existing MCTs would provide much useful data as input in new MCT planning, as well as a basis for road, access, and parking requirements.

302. Queueing at Entrances of MCTs

This is a traffic problem more often caused by faulty design of the MCT or by operational problems within the terminal area. The great expansion of container shipments in recent years may tax the capacity of terminals built years ago when shipments by containers were less numerous. Operational difficulties and essential paper work within the terminal may force trucks to queue up on the adjacent highway because there is lack of space within the terminal area for waiting.

The frequency and severity of the queueing problem can be determined by traffic counts and delay studies. Whether there is a correlation between the number of ships alongside and the number of trucks lined up waiting to enter the terminal may be determined by trip-end generation studies.

In some instances, queueing may be alleviated by constructing parking bays along the roadway and by scheduling trucks and tractor arrivals and departures. The latter is more easily accomplished by large terminal operators that control their own transport.

303. Access to MCT

Access problems are related to the number and types of roads serving a terminal, including feeder roads. Traffic signals and their timing are part of the problem and the solution. Traffic count and trip-end generation studies are applicable.

304. Parking and Storage

Parking and storage problems, like queueing problems, are more likely due to MCT design and operations. In some cases, the lack of parking facilities within the terminal forces employees and others to park outside along the roadway or off the roadway in areas not designated for parking.

Origin-Destination studies would provide information which, when augmented with analyses of present land use, growth trends, proposed route changes, could provide a basis for improving the parking situation both for automobiles and trucks.

305. Signs

One of the more serious traffic problems in and around port areas is the lack of adequate signs directing incoming traffic to their port destinations. Instances have occurred where trucks have lined up in a queue only to find that they were in a queue to the wrong terminal. Terminal employees and regular truckers usually know where they are going. Truckers from out of town, though, often have great difficulty in finding their destinations. The problem is accentuated when a turnoff is missed and there is not adequate turning area in the road ahead.

To judge the adequacy of signs, interview type questionnaires are used. These may be combined with other questions and passed out to truckers lined up in queues. The cooperation and possibly the assistance of the terminal operators may be required in administering these questionnaires. Another method is to engage the consultant services of expert traffic engineers to study the layout.

306. Highway and Road Design

The traffic capacity of roads in and around port areas is influenced by the

physical characteristics of the road, the nature of the traffic, and the control exercised over traffic using the road. Such characteristics as width, number of lanes, type and width of shoulders, condition of surface, turning path at intersections, traffic signal timing all bear on the problem.

The traffic capacity of a given road can be estimated by calculating the road's theoretical capacity and then modifying it to allow for existing conditions such as:

- cross or intersectional traffic
- merging traffic
- marginal entrance of parked vehicles into the traffic stream
- interference with vehicles going in the same direction
- medial interference by vehicles going in opposite directions
- vehicle mix

A substantial number of trucks with trailers on the roadway will reduce normal traffic volume by one-half to two-thirds because of the need for greater vehicular headway between the trucks.

It is doubtful whether a port would be required to make the extensive calculations that go into major roadway design. Ports, however, would be concerned with aspects of the problem discussed above and should have some ideas of the magnitude of the impact of these various factors on existing roadways. This is discussed further in the methodology for various types of studies.

307. Ship Coordination

In a busy MCT, with a number of ships loading and unloading at a terminal, a larger volume of trucks entering and leaving the terminal may create traffic problems.

In a survey taken at one port, it was found that truck traffic moved in and out of the MCT daily with little observable differences in numbers of trucks caused by the presence of container vessels loading and unloading at berths. Whether there is a definite correlation between the presence of container ships in berths and truck traffic can be determined by traffic count studies.

308. Accidents

The records of traffic accidents including the accuracy of the basic information are indispensable guides for port authorities concerned with the death, injuries, and economic waste caused by vehicles colliding. Accident causes are often difficult to ascertain. Most accidents occur when the weather is good, with vehicles in good mechanical condition, driven by average drivers. Many accidents occur, however, at certain intersections or road locations in such numbers that one must conclude that the physical layout and traffic guides were contributory causes.

Traffic accident investigations are usually the responsibility of the police agencies. Accident files are maintained by state and local police agencies containing detailed information as to what happened and what conclusions were drawn from the investigation. These files can be examined to indicate intersections and locations under port jurisdiction where frequent accidents (five or more during the year) occur. From the assembled data, traffic accident analysis of the location may be made which might uncover traffic deficiencies such as poor visibility of signal heads, lack of left turn signals, no pavement approach markings, etc.

309. Traffic Studies Applicable to MCTs

The five basic study methods related to these nine types of traffic problems are shown in a matrix on the next page. These study methods are discussed in detail in the following sections.

4. TRAFFIC COUNT STUDIES

400. Purposes

Traffic count studies are among the most useful studies in traffic analysis. The purposes of counting vehicles passing a certain point are as varied as the locations where the counts are made. Fortunately, MCTs provide site characteristics that are ideal for analytic purposes:

1. Only one or a few entrances
2. Little or no through traffic
3. Single land use
4. Off-street parking and storage

Matrix of Traffic Studies Applicable to MCTs

TYPE OF STUDY	PURPOSE	APPLICABILITY OF STUDY	PERSONNEL & EQUIPMENT	PORT TRAFFIC PROBLEMS ADDRESSED
TRAFFIC COUNT	To obtain accurate record of numbers, directional movements,and variations in volume of traffic.	Planning for route changes, determine adequacy of traffic control devices, set priorities.	Observers with watches, counters, and field sheets. Automatic counters.	All
ORIGIN-DESTINATION	To develop data on movements between MCTs and outside zones.	To support traffic engineering and consultation requirements. To support port land use plans in connection with growth trends.	Varies with scope and type of study. May require interviews.	Administrative Facility Planning
TRAVEL TIME & DELAY	To determine time to traverse a route and the cause, location, and amount of delay of various segments.	To survey alternative routes, indicate means to eliminate congestion. To evaluate control devices.	Observers with watches, stop watches, field sheets and an unmarked car.	Queueing Access to MCT Signs Road Design Ship Coordination
PARKING & STORAGE	Determine adequacy of existing or planned parking spaces.	Reduce excessive illegal and overtime parking. Eliminate congestion at entrances of MCTs. Long-range planning.	Port maps, field and summary sheets, aerial photos.	Facility Planning Parking and Storage Queueing
ACCIDENT RECORDS	To improve traffic safety in port area.	Identify high accident locations. Assist in traffic design evaluation. Establish priorities and measure effectiveness of remedial action.	Professional traffic analyst preferred. EDP summaries. Report analyses.	Accidents Road Design Access to MCT

MCTs, however, have certain characteristics that offer problems in making meaningful traffic counts. For example, there is a mixture of trucks and automobiles, with a higher percentage of trucks than normally encountered. Automatic counts that register only the passage of wheels or axles cannot differentiate between the passage of a truck-trailer combination with, say, six axles, and the passage of three automobiles.

Traffic count studies around MCTs are used to:

- Determine the number and type of vehicles travelling in, out, or through the port area.
- Provide an input into accident studies.
- Obtain useful data for planning route changes, new terminals, and environmental impact studies.
- Determine the need for signs, signals and pavement markings.
- Establish road paving specifications based on axle loads and vehicle frequencies.
- Set roadway maintenance, construction and improvement priorities.
- Assist in parking studies.

As far as the port is concerned, traffic count studies provide some of the most significant factual data required as backup to persuade the municipal, county, or state authorities in charge of the roads and streets to make needed improvements to the traffic system.

401. Methods of Counting

Manual counting is most applicable for MCTs since it provides a method of classifying the vehicles counted in various categories and permits the checker to record turning movements at intersections and at entrances of the MCT. Due to the high cost of manual counts, they are often supplemented by automatic counts.

Manual counting is accomplished by the use of tally sheets and timers. If the volume of traffic is heavy, it may be necessary for the checker to use manually operated tally counters. This eliminates the need for the checker to take his eyes off the road to make tally marks. At intersections where turning movements are needed, four sets of three counters each may be mounted on a board. The sets represent the four different directions of approach and the three counters indicate the direction of turn: left, straight ahead, or right.

There are more sophisticated counting systems, some automatic, with electronic scanners that register vehicle identification. The vehicle identification counters are likely to be employed by MCT operators, scheduling and marshalling containers for shipment inside the terminal. Still, the data may be made available to the port on request, especially if the findings could be put to use by the operator.

402. Time and Length of Study

Depending on the circumstances, vehicle counts should be made to cover ten, twelve, or twenty-four hours, when automatic counters are used. Manual counts are usually made during the two peak hours, and one typical off-peak period. These counts can then be expanded to high ten or twelve hour periods or to a typical twenty-four hour period, based on the automatic counts. Counts should usually be made in good weather Monday through Friday to record the normal flow. Of course, if there are recreational areas or other activities near the port, the count could be extended through the weekend to see if there are sharp variations from normal usage.

The count should begin at least one-half hour before and at least one-half hour after the major periods of traffic flow. Traffic count studies may be made over a period long enough to determine the variations due to ship arrivals at, and departures from, the MCT.

Intersection and ramp turning-movement counts normally should be recorded at fifteen-minute increments, although five-minute increments may be preferable in some situations. The count should include the morning peak, mid-day and evening peak periods, and normally should not be less than two hours in duration. Ideally, all counts should be made twice. A third count should be conducted if an unexplainable discrepancy occurs between the first two counts. It has been determined that in large urban areas the twenty-four hour volumes taken on typical weekdays can be considered to represent the annual average daily traffic (AADT). The accuracy of such counts can be expected to be within a range of ± 10 percent. This range is reduced to ± 7 percent if monthly seasonal adjustment factors are applied. Summaries of turning-movement counts normally indicate the highest peak-hour volume and the highest fifteen-minute peak period. Tabulations of approach volumes can be prepared to show the percent change in traffic flow or other desired comparisons.

403. Trip Generation and Land Use

Traffic is generated by each land use and the pattern begins to take shape according to the particular use. Thus, accumulated traffic counts can establish the number of trips generated from apartment houses per inhabitant or from the professional district per net acre or 10,000 square feet of office space.

Similar calculations may be made for MCTs in relation to acres of storage space, tonnage shipped, etc. The same procedure could be used to determine correlation of truck traffic with container ships at berths in the MCT.

404. Cordon Counts

Cordon counts are particularly appropriate for port areas where the number of specific types of motor vehicles entering or leaving the adjacent areas is needed. A continuing program of cordon counts will provide data on trends of traffic volume. This would be helpful in routing container truck traffic and planning for improvements to access roadways.

The cordon count program should encompass all roadways within the adjacent area of a port over which container truck trailers pass. The area encompasses is usually defined by bordering expressways or major arteries.

405. Forms

Three types of forms can be used in traffic count studies: field sheets, summary sheets, and graphic summary sheets. The forms may be designed for particular applications or the standard forms used by state, county and traffic engineers may be adequate.

Form A (in the appendix) is an example of a field tally sheet designed for an intersection count. The sheet could be used to record the number of containers, trucks or automobiles going into and leaving the MCT, whether the entrance of the MCT is at a crossroad or not. All that is necessary is to indicate a tally mark in the proper block for truck with container, truck without container, or automobile. A truck with two containers could be given two tally marks.

A new tally sheet would be used for each hour or each half-hour and summarized on the summary sheet shown in Forms B1 and B2.

A graphic summary sheet, such as shown in Form C, could be made out for each classification of vehicle used, showing the total numbers in each direction daily.

406. Data Reduction and Analysis

The breakdown by time, type of vehicle, and location can alone provide useful conclusions. For example, peak traffic hours are easily isolated. The percentage of traffic given to trucks carrying containers compared to trucks moving with empty trailers or as tractors alone are easily calculated.

In conjunction with other background information, one can calculate the number of containers entering an MCT each day per terminal acre, per acre of storage area, per container ship berth, per container crane. Alone these figures may be meaningless, depending on the system adopted by the MCT operator. But the accumulation of such information by ports in the United States and correlated by a Federal Agency such as the Maritime Administration could in time result in the establishment of criteria for roads and traffic control devices, serving MCT operators, which do not now exist.

5. ORIGIN-DESTINATION STUDIES

500. Purposes

Origin and Destination (O & D or O-D) surveys develop information and data on numbers and types of trips including movements from outside zones to the MCT and from the MCT to outside zones. The surveys are normally conducted for transportation planning purposes and should be augmented with analyses of present port land use, traffic growth trends, and proposed route improvements.

501. Planning an O-D Survey

Since an O-D survey provides information on the origin and destination of trucks using an MCT or similar information on cars transporting employees and stevedores, permission must be obtained from the MCT operator to conduct the study. An O-D survey can be complicated or simple depending on the purposes for which it is designed. These purposes need to be clearly explained to MCT operators to obtain their cooperation and assistance.

Normally, the number of daily trips of trucks entering and leaving an MCT are large enough to employ sampling methods. If the numbers are small, a total sample is feasible. However, if smaller samples are used, it is essential that the sample be large enough to satisfy the bounds of accuracy and the level of confidence desired. Traffic volume counts are important here to expand the O-D sample to account for the total traffic.

502. Zoning

O & D surveys should begin with the delineation of a survey area. Container trucks may come from various centers of population in the hinterland, or they may have local origins and destinations (e.g., drayage to rail ramps or TOFC/COFC terminals). It would simplify the summary of O-D information or data if the origins and destinations were included in zones that are

numbered for coding purposes. The assumption would be made that the beginning or ending of all trips is located at the mid-point of the zone.

Normally, the selection of zones would ba apparent. TOFC/COFC terminals would qualify as would major container freight stations. Hinterland destinations could be grouped together according to the major freeway leaving the port city to the various destinations.

503. Personnel and Equipment

Manpower requirements will vary widely depending on the complexity of the survey and the method used. Equipment may include questionnaires, self-addressed post cards, up-to-date road maps, watches, and possibly electronic data processing equipment for tabulating information and summarizing results.

504. Methods of Conducting an O-D Study

Traffic Engineering Handbooks list some dozen methods for conducting O-D Surveys. For MCTs, the three methods below will usually suffice:

a. Post Card
Prepaid post cards with return address and questionnaire could be distributed at gates during the working day. Questions should be simple and limited to basic information required. Both post cards and registration questionnaires may be transferred to EDP punch cards for computation and summary.

b. Roadside Interview
Roadside interviews require advance publicity and authorization. Such interviews may be conducted at the gates of the MCT while trucks are waiting to enter. Interviews may be extended over a period of several days. A simple strip of tape on the bumper could indicate truck drivers that have already been interviewed. Interviews should normally take less than a minute. A well-organized interview procedure is required for producing sound statistical results.

c. Tag on Car, or "Lights On"
Where it is desired to know travel patterns of trucks originating from or destined for an MCT, tags may be placed on the trucks to differentiate them from other trucks using access roads. Another variation is to request MCT trucks to keep their lights on during the daytime as long as the survey is being conducted.

505. Questionnaire

Port authorities would mainly be concerned with O-D questionnaires for employees and for container trucks.

Employee questionnaires should be distributed and turned in the same day. The completed form should be coded in order to facilitate electronic data processing of the information. Information on where employees live, how they get to work, where they park the car, how much it costs, how long it took to drive, how many passengers, etc., can be obtained for each employee. The information could be used in parking surveys or for justifying roadway or parking improvements or for the routing of public transit.

Container truck O-D questionnaires may be comprehensive and include a travel day log of all stops, pickups, and deliveries. A port, however, is concerned mainly with that portion of travel involved with pickup and delivery of containers, empty or filled. Such a questionnaire could be issued to all drivers calling at an MCT. Since one of the essential pieces of information required is the length of time and distance the truck travelled on its way to the terminal from its origin, the interviewer would request this information for the next trip to the MCT. In other words, the times recorded on the questionnaire would commence with the arrival at the truck at the terminal and end when the next pickup or delivery is made. Minimum information should include:

Date and Time: Arrival at MCT

Date and Time: Departure from MCT; Odometer reading
Pickup or Delivery
Full Container or Empty

Date and Time: Arrival at next destination; Odometer reading
Destination
Pickup or Delivery
Full Container or Empty
Distance from MCT

Reason for: Intermediate stops (These should be coded)

Date and Time: Departure of origin for MCT; Odometer reading
Origin

Date and Time: Arrival at MCT; Odometer reading
Pickup or Delivery
Full Container or Empty

Form D is a suggested Container Truck Travel Log, designed for the minimum information listed above. Additional background information could be added as desired.

506. Desire Line Flow Diagrams

Summaries containing trips between MCT and zones selected (rail ramps, garages, CFSs, major highways serving the hinterland) could be represented on a desire line flow diagram. An example is shown in Figure 5-1. The average volume of traffic is represented by bands whose width is relative to the volume.

Figure 5-1 Hypothetical Desire Line Map for the Port of Oakland

A detailed matrix similar to Figure 5-2 would show more precisely the numerical volume of traffic between O-D zones. Actually, it will be found that many of the container trucks will be moving between the MCT and Garage or between the MCT and the CFS. To accommodate movements between zones, the matrix could include destinations other than MCT.

Figure 5-2 Hypothetical Daily Numbers of Containers to Match Desire Line Diagram

ZONES AND DESCRIPTIONS	PORT OF OAKLAND			
	MARINE CONTAINER TERMINALS			
	MATSON	SEA LAND	U.S. LINES	TOTAL
1. North and East	20	80	10	110
2. SF local and peninsula	110	90	50	250
3. Southern Pacific RR	30	--	20	50
4. South	30	105	45	180
5. San Joaquin Valley	5	30	15	50
6. Oakland RR Ramps	20	10	20	50
7. Oakland local	15	40	40	95
	230	355	200	785

507. Analysis

Most O-D surveys result in large quantities of data that require the use of electronic data processing for effective analysis. For the relatively uncomplicated O-D surveys for a port or MCT described above, summaries and analyses may be accomplished with pencil and paper.

Future travel patterns may be estimated by projecting trade and transportation trends ahead for a given number of years. In making these projections, other external factors should be evaluated, such as the construction of industries near the port area and the installation of railroad ramps within major MCTs, etc. These could significantly alter the amount and pattern of truck traffic.

Such O-D studies combined with associated land use and growth trend studies provide inputs for parking and storage studies.

6. TRAVEL TIME AND DELAY STUDIES

600. Purposes

The purpose of a travel time study is to determine the total time required to traverse a certain route. The purpose of the speed and delay study is to determine the cause, location, and amount of delay along various segments of the route.

The travel time study would be useful for MCTs in economic analyses, such as relating freight and drayage charges to the travel time of trucks transferring containers from rail ramps to the terminal areas and vice versa.

Speed and delay studies would be useful in determining specific delays and bottlenecks on congested streets that reduce efficiency of drayage operations.

601. Planning Travel Time and Delay Studies

Routes used must be carefully identified; the total length and location of key landmarks along the route should be accurately posted on the field sheets. Normal peak traffic hours for both morning and afternoon in each direction should be determined prior to the survey.

602. Travel Time

For a simple travel time study between two points, all that is needed is for an observer at each end of the route to record the time and last three digits of the license plate of trucks departing and arriving at the observation posts. These license plates with their respective times are matched later to determine elapsed travel time.

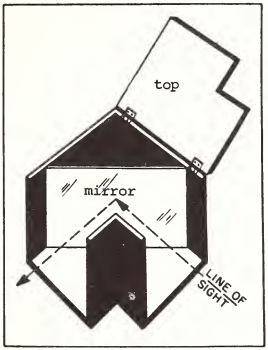
Such a simple study is usually inconclusive, since many elements of delay are absorbed in the overall results. It is often necessary to break the travel time analysis in component parts.

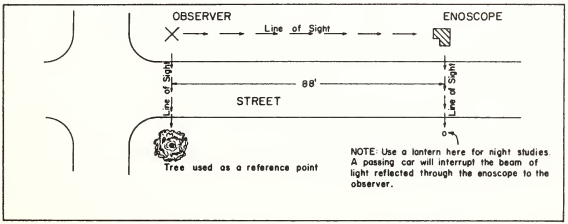
603. Spot Speed Studies

Spot speed studies are conducted to measure the speed distribution of vehicles on a relatively short section of roadway such as the access road to an MCT. Here the port is interested in the average speed at various times during the work day. This is derived from dividing the sum of the vehicle speeds by the number of observations.

The most simple and least expensive device to measure speed is an enoscope. The enoscope is a box open at 90 degree ends with a mirror set at 45 degrees angle at the corner. Figure 6-1 illustrates an enoscope set up for measurements. The distance of 88 feet is used because it facilitates converting the number of elapsed seconds for the vehicle to travel 88 feet directly into the vehicle speed in miles per hour. For example, if the vehicle takes 1.3 seconds to travel 88 feet, it is going 46 m.p.h. (60 ÷ 1.3 = 46).

Figure 6-1 Enoscope set up for Measurements

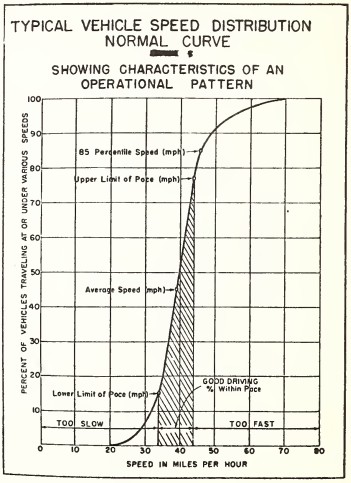




Since the development of various radar devices, the enoscope is hardly ever used. The radar meter operates on the doppler principle. The radio wave reflected from a moving target has its frequency changed in proportion to the speed of the moving target. The major advantage of such a radar meter is that it can be set up in an inconspicuous location off the roadway. The driver is unaware of its presence and his driving behavior is not influenced.

A simple tally sheet is used to record the speed of the vehicles observed. The tally sheet could be broken down further in columns representing types of vehicles. From the tally sheet, a summary is made showing the maximum speed and the 85 percentile speed (that speed below which 85 percent of the vehicles travelled). The spot speed data could also provide the ten mile per hour pace and standard deviation. The "pace" is the 10 m.p.h. range of speeds containing the largest number of observations. Figure 6-2 shows a typical vehicle speed distribution curve on a given stretch of road. At least 50 and preferably 100 or more vehicles should be measured in any one sample.

Figure 6-2 Typical Speed Distribution Curve

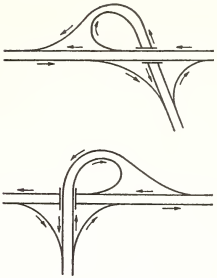


605. Intersection Performance and Delay

Trucks leaving an MCT often must enter into a traffic stream flow. Where traffic is light, no difficulty may be experienced. Where traffic is heavy, it may be necessary to interrupt the traffic stream by signals. Where traffic from the terminal or port area is heavy as well, it may be necessary to construct an interchange such as Figure 6-3.

In either case, factual traffic count data are required to justify the installations.

Figure 6-3 T Interchange



606. Speed and Delay Studies

Port authorities, normally, are not concerned with speed and delay studies outside of their jurisdictions and the immediate adjacent areas. They are, however, concerned with travel time studies along access roads to MCTs and travel time in overall O-D surveys. The most useful method for isolating points of congestion or delay is by the use of a test car. In brief, in the driver's judgment, the test car is driven at a speed that is representative of all traffic at the time. The observer in the vehicle starts one stop watch at the beginning of the trip and records the time of arriving or passing designated landmarks or control points along the route. A second stop watch is used to record the length of individual stops. The cause and location of the delay may be recorded on a special form or by use of a tape recorder.

607. Time and Length of Study

Usually peak and off-peak hours of traffic are included in the speed and delay study. These times should be determined from traffic counts before the travel time studies are initiated. Analyses of previous studies have indicated that 12-14 runs in each direction during peak and off-peak periods are required to obtain results within a ± 10 percent error. A separate field sheet should be used for each run. Form E illustrates a typical field sheet. Figure 6-4 shows the speed delay characteristics of principal roadways in a hypothetical port area.

Figure 6-4 Speed-delay characteristics of principal roadways in a hypothetical port area

1.	Length (miles)	1.7	0.8
2.	Posted speed limit (mph)	35	30
Off-Peak Hours			
3.	Travel Time (min-sec)	3-27	3-10
4.	Total Time Stopped (min-sec)	0-01	0-30
5.	Average Speed (mph)	32.5	16.0
6.	Running Speed (mph)	32.6	19.2
Peak Hours			
7.	Travel Time (min-sec)	3-32	4-49
8.	Total Time Stopped (min-sec)	0-22	2-20
9.	Average Speed (mph)	31.7	10.0
10.	Running Speed (mph)	32.4	18.2
11.	Average Peak Hour Speed as Percentage of Average Off-Peak Speed (line 9 ÷ 5)	97.5%	62.5%

608. Applications

Examination of the data of a properly executed study could result in defining points of congestion and time congestion occurs. Excessive delays may be caused by:

- Inadequate traffic control at intersection or, conversely, too much traffic control
- Ineffective and improper signs
- Improper timing of signals
- Parked vehicles obstructing flow
- Turning movement delays
- Insufficient roadway capacity

609. Speed Zoning

Speed regulations are a restraint on the freedom of a driver to choose the speed at which he desires to travel. They should be imposed only to the extent that they improve traffic flow and reduce hazards. Generally speaking, traffic laws that reflect the behavior of the majority of the drivers are found to be successful. Laws that arbitrarily limit speed encourage wholesale violations.

Speed zone regulations should therefore be based on criteria that are reasonable and safe. Some states have adopted warrants for speed zones that prescribe the conditions governing the need for speed regulation. Certain factors should be reviewed in any study before establishing speed zones. These include:

1. Prevailing vehicle speed
   a. 85 percentile speed
   b. 10 mph pace
   c. Average test runs

2. Physical features
   a. Design speed
   b. Spacing of intersections
   c. Roadside businesses
   d. Roadway configuration and surface characteristics

3. Accident experience

4. Traffic characteristics
   a. Volume and control
   b. Climactic conditions

Guidance for the proper selection of speed zones is contained in the Uniform Vehicle Code published by the National Committee on Uniform Traffic Laws and Ordinances, 711 - 14th Street, N.W., Washington, D.C.

7. PARKING AND STORAGE STUDIES

700. Purposes

The purpose of parking studies is to determine the adequacy or efficiency of existing parking spaces or planned parking spaces. The two elements of supply and demand are basic to such studies.

For existing MCTs, comprehensive parking surveys are needed only in connection with new development plans or major changes in the installation. Normally, studies are designed for specific problem areas such as:

- Excessive, overtime, and illegal parking
- Cruising to find a parking space
- Congestion due to queues of vehicles attempting to park

701. Parking Characteristics of MCTs

In a properly designed MCT, parking facilities would be provided for employees and longshoremen without the necessity of parking vehicles on roadways. Space would be assured at entrances for container trucks to wait while documents are being checked. The storage and marshalling areas of the terminal would be adequate for trailers with or without containers.

As volume of container shipments increases, the MCT must either provide additional land for parking and storage, speed up the loading and unloading operation, or change the system of container loading, unloading, and storage to one that will be accommodated within the limited land space available. In many cases, none of these solutions is feasible, and trucks are forced to wait outside of the terminal on the roadway until the limited operation within the terminal is able to accept them.

Parking spaces for employees will also become more crowded as container shipments increase, particularly for longshoremen and others who are hired on an hourly basis in relation to the size of the work load.

702. Method for Automobile Parking Studies

Parking studies for MCTs can be generally classified as parking inventories and parking usage studies. The first is applicable to permanent parking for employees and storage of trailers. The second is applicable to temporary parking for visitors and transient truck deliveries. MCTs are more concerned with the deficit created in permanent parking and storage than with the turnover of vehicles using transient or visitor parking facilities.

Normally, an installation map of the port or MCT would indicate the permanent parking spaces available for various purposes. The deficit in parking spaces can be determined by subtracting this inventory of parking spaces from the number of spaces required.

The required number of parking spaces (RPS) can be approximated by:

$$RPS = \frac{\text{Number of personnel X automobile factor}}{\text{Average vehicle occupancy X efficiency factor}}$$

- Number of personnel includes all MCT permanent employees and peak load longshoremen.
- "Automobile factor" is the percentage of personnel coming to work in private automobiles.

- "Average vehicle occupancy" is based on the number of personnel normally brought to work in each automobile. This number is usually somewhere between 1.2 and 2.0.

- "Efficiency factor" provides additional spaces for occasional overflow and to speed up the parking operation without congestion. A factor of 0.85 to 0.95 will usually provide the necessary reservoir.

703. Parking Usage Surveys

MCT normally provide special parking spaces for visitors and transient truck deliveries. If the number of transients is large, it may be necessary to conduct a usage survey to determine whether the number of parking spaces assigned is adequate.

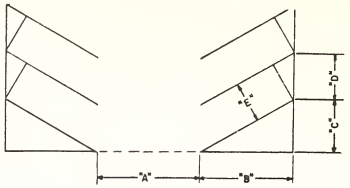
The observer records the last three digits of the license number in each parking space at regular intervals (fifteen or thirty minutes). One observer can check sixty spaces each fifteen minutes. Form F is an example of a parking usage survey sheet. Check marks indicate that the automobile recorded in a column is still parked at the subsequent check interval. The letter "E" indicates that the parking space is empty.

This information can be summarized to obtain the average duration of parking, percent overtime parking, and utilization factor. For transient parking, a utilization factor over 0.85 indicates a problem: the higher the utilization factor, the greater the problem.

704. Interpretation and Remedies

The determination of parking space deficits in itself usually suggests alternative remedies. If the deficit is small, it may be a matter of redesigning the parking layout, or encouraging driving pools to raise the average vehicle occupancy factor. If the deficit is large, it may support a request for instituting public transportation to the port area. Figure 7-1 shows dimensions for parking stalls for various types of parking.

Figure 7-1 Dimensions for parking stalls for various types of parking

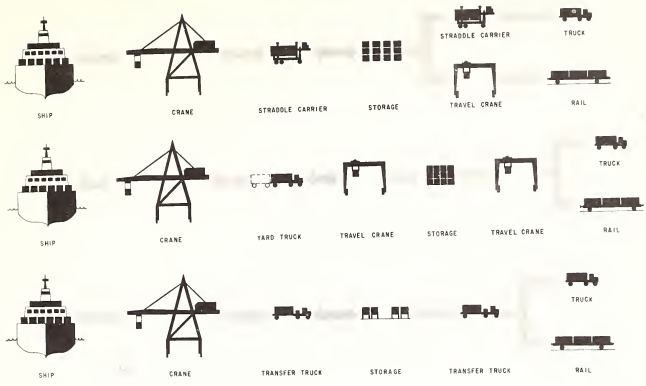


Type parking	*Square feet per car*	*A*	*B*	*C*	*D*	*E*
Parallel	297	12′	8′	—	22′	8.5′
35°	335	11.5′	15′	21.4′	14′	8.5′
45°	299	12′	19′	13′	12′	8.5′
60°	276	18′	20′	10′	9.8′	8.5′
90°	228	25′	19′	—	8.5′	8.5′

705. Storage Space

The amount of acreage devoted to storage of containers and trailers in marine container terminals varies with the system design and the amount of land available. In the final judgment, economics dictate the system adopted. Once a system has been adopted, an immense amount of capital is required to change to another system or to purchase additional land. For example, one expert considered that a one-berth terminal, capable of handling 1,000,000 long tons a year, would expect to handle 2,300 small trucks at the CFS and another 900 truck-trailers arriving to deliver or to pick up containers each week. Many one-berth terminals can handle more; some less. Figure 7-2 shows in a flow diagram three different operational systems at an MCT.

Figure 7-2 Various Operational Systems at MCTs



(illustration courtesy of Kaiser Engineers)

706. Adapting to Lack of Storage

Inadequate storage spaces within the MCT marshalling and storage area may be corrected by change in labor and consignee practices. There must, however, be agreement that the change in practices will result in an economic gain to each concerned party. This, in turn, requires some factual traffic investigation.

One solution proposed is to utilize night, or after-hours trucking and transfer of containers between ship and shore. As long as operations are not saturated, this solution may result in additional costs of overtime. But when the situation arises that an MCT is unable to handle the volume of container shipments within the present design and no additional land is available, then it might be worth investigating the economics of night operations.

Some considerations applicable to such a storage problem are:

- Night trucking will give haulers an opportunity to increase the daily utilization of their equipment, thus gaining a greater

return on their investments. It will also cut transit time that is required in heavy daytime traffic.

- Freight forwarders could speed up distribution by stripping containers at night. Better service may have its reward in customer satisfaction and increased profits.

- Warehouse operations of major consignees may save money by greater turnover in the warehouse.

- MCT operators may save on investment in land and containers by the more effective utilization of existing equipment.

Traffic studies outlined in this manual will contribute to the economic studies required in searching for a solution to the storage problem.

8. ACCIDENT RECORD STUDIES

800. Purposes

As pointed out in section 308, accident investigation is usually the responsibility of the police agencies. In some circumstances, the Occupational Safety and Health Administration and the Department of Transportation may be involved in traffic accident investigations. The municipalities, counties, or agencies collect information on individual accidents, but they also make traffic control and engineering recommendations. Analysis of accident records serve to:

- Identify high accident locations.

- Provide support for evaluating roadway design.

- Provide guidance in programming improvements and remedial action to correct deficiencies.

- Furnish a basis of comparison for "before" and "after" studies of actions taken.

801. Planning Accident Records Studies

All states require drivers to submit traffic accident reports on a special form to some responsible state agency. The National Safety Council has developed standard content specifications for police and driver accident reports. A model of such a report is shown in Form G. Many of these data elements are found on special forms used by state and municipal agencies.

Often for a port area, accident data can be found in a convenient EDP format.

For more productive engineering use of accident reports, they should be filed by location, or if filed chronologically, they should have a cross-reference index file.

Five steps are followed in planning a traffic accident report study of a particular port location. These are:

1. Obtain all accident report data available for the location being studied.

2. Prepare collision diagrams and physical condition diagrams.

3. Summarize facts.

4. Make field observations at location during hours of most frequent collisions reported.

5. Analyze and prescribe action to remedy deficiencies.

802. Traffic Spot Maps

Each port should maintain a traffic spot map identifying locations with high accident frequency. The map should be detailed enough to include complete roadway networks of the port and surrounding area.

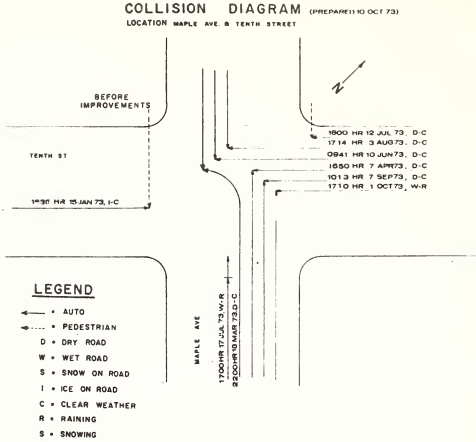
Pins of various colors signifying accident types, injuries, and damages are stuck into the map at intersections or locations where accidents have occurred.

803. Collision Diagram

The collision diagram is used to summarize accidents that have occurred at high accident frequency locations. For the collision diagram to be useful, it should be based on complete and accurate accident report records.

The collision diagram is an outline map of the location on which accidents have been recorded by symbols and lines showing directions of movements of vehicles and pedestrians. Figure 8-1 shows a typical collision diagram. Note that it includes the date and time of accident and the road and weather conditions at the time. Separate diagrams are required for "before" and "after" traffic remedial action has been taken.

Figure 8-1 Collision Diagram



Once an accurate collision diagram has been made, points of similarity will be revealed. For example, the majority of accidents might have occurred with cars moving in one direction or another. Poor condition of lighting might show up in a sizeable number of collisions. Bad weather might appear to be a contributory cause in a large number of accidents.

804. Condition Diagram

The condition diagram shows the physical condition at the location. The following items are recorded:

- Curbs or roadway limits
- Sidewalks, driveways

- View obstructions (such as billboards, buildings, trees)
- Physical obstructions on or near roadways
- Ditches, bridges
- Grades and direction
- Road signs and traffic signals
- Condition of roadway

805. Field Observations

Field observations are made in conjunction with both collision and condition diagrams. The observation should be made under similar circumstances indicated in the collision diagram. For example, it may be determined that a building on a corner obscures the vision of two drivers to the extent that they are not able to see each other while proceeding at normal speed in time to react to avoid an accident.

806. Conclusions and Recommendations

Compilation of accident data is of little value in itself. It must be summarized in understandable form that lends itself to points of similarity. If certain conditions influence the driver, the vehicle, the roadway, or traffic control devices, accidents may occur. If accidents have occurred due to these conditions, it is fair to infer that accidents will occur again.

807. Applications

Results of analysis of accident causes, effects and remedies may be applied to:

- Determine accident reduction measures
- Justify expenditures for changes in physical layout and design
- Reveal need for traffic supervision
- Disprove impractical remedial suggestions
- Point up need for maintenance
- Assist in developing programs of signal and sign installation

- Assist in justifying additional budgetary funds for promoting traffic safety

- Establish a record of concern for the Occupational Safety and Health Administration and show the effectiveness of remedies

9. HIGHWAY CAPACITY AND CONTROL DEVICES

900. Traffic and Highway Engineering

Traffic engineering is a specialized branch of civil engineering concerned with the control and safety aspects of highway transportation. Highway engineering is concerned with the design and construction of highways. Both engineering disciplines rely on traffic demand, either present or predicted, as a basis for designing highway capacity and installing control devices such as traffic markings, traffic signing, and traffic signalization.

The traffic problems associated with MCTs and the studies that are conducted to alleviate or ameliorate these problems result, in most cases, with recommended solutions that call for improvements in highway capacities or changes in control devices. Accordingly, this section is designed to inform port personnel responsible for traffic studies of some basic standards and reference guides in these engineering fields.

901. Roadway Capacity

Capacity is defined as the maximum number of vehicles that can pass over a given section of roadway during a given time period under prevailing roadway and traffic conditions. Any change in these two conditions--the physical features of the roadway and the transient conditions of the traffic--would result in a change in capacity.

Although capacity is important in defining the limit of traffic, it is misleading because it gives no indication of operating conditions. Thus traffic engineers have adopted other criteria called "level of service," which denotes the different operating conditions. It is a qualitative measure of the effect of speed and travel time, traffic interruptions, freedom to maneuver, driver comfort and convenience, etc.

There are six levels of service designated by letters A through F, from best to worst. These are defined in Highway Capacity Manual, Highway Research Board, 2101 Constitution Avenue, Washington, D.C.

902. Roadway Factor

These factors represent the influence of restrictive physical features incorporated in the design of a highway, such as:

Lane width	(12-14 feet)
Lateral clearance	(6 feet desirable)
Shoulders	(6 feet)
Auxiliary lanes	(speed changing, truck)
Surface conditions	
Alignment	
Grades	

903. Traffic Factors

Highway capacity is affected by changing traffic conditions in its use. Traffic factors include:

Trucks	(equivalent to 2 or 2 1/2 cars)
Buses	(equivalent to 1.6 passenger cars)
Lane distribution	(median lane carries more traffic)
Variations	(peak hour)
Traffic interruptions	(stop lights, toll gates)

904. Traffic Markings

Pavement markings serve to guide, channelize and to supplement the regulations or warnings of other traffic control devices. They give information for turning movements and serve as psychological barriers for streams of traffic. Pavement markings indicate the proper driving path, passing restrictions, crosswalks for pedestrians, intersection stop points, etc. The types of markings, the materials, and the colors are prescribed by the Manual on Uniform Traffic Control Devices for Streets and Highways, published by the U.S. Department of Commerce, Bureau of Public Roads, U.S. Government Printing Office, Washington, D.C.

905. Traffic Signing

Traffic signs are divided into three general categories:

- Regulatory signs--imposing legal restrictions which are usually unenforceable in the absence of such signs.
- Warning signs--calling attention to hazards that may not be otherwise apparent.
- Guide signs--route marking, directional and informational nature.

In general, traffic signs assist the driver by simple, clear, and effective messages at locations that provide adequate decision-reaction time. Signs are standardized and identified by shape, color, size and legend. These distinctive characteristics are outlined in the Manual on Uniform Traffic Control Devices for Streets and Highways.

Good traffic signs should:

- Stand out from background so that they may be seen at a distance related to the approach speed, to allow them to be read and understood.
- Be of sufficient size to carry lettering and symbols that are readable within approach distances.
- Provide sufficient decision-reaction response time.
- Be succinctly worded to be fully understood at 85 percentile speeds.

906. Traffic Signalization

The primary function of traffic signals is to regulate the flow of traffic at intersections in such a way that right of way movements are alternated. Traffic signals are not inherently "safety" devices for they may cause as well as reduce accidents. At intersections where there is little traffic volume, traffic signals may even increase delay.

Properly designed, traffic signals could:

- Provide for the orderly movement of traffic.
- Reduce right angle accidents.
- When properly coordinated with other signals along a roadway, speed up traffic flow.
- Provide safe crossing or entering intersections for pedestrians and other traffic.

Traffic signals may be pretimed, progressive systems, or traffic actuated. Each of these systems has advantages and disadvantages. If an MCT exits onto a busy thoroughfare, it may be advantageous to consider traffic actuated signals, in order to stop the heavy traffic momentarily as container trucks enter the traffic stream. Guidance for the proper selection of signal systems is contained in the Manual on Uniform Traffic Control Devices for Streets and Highways.

907. Traffic Engineering Handbooks

Besides the reference guides cited in the previous paragraphs, the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018, publishes manuals and guides on the same subjects. In addition to these sources, two general traffic engineering handbooks should be consulted:

1. Traffic Engineering Handbook
   Institute of Traffic Engineers
   Washington, D.C.

2. Manual of Traffic Engineering Studies
   Institute of Traffic Engineers
   Washington, D.C.

Access road
: Public roads leading to a defined installation or facility, such as a port or marine container terminal (MCT).

Container Freight Station (CFS)
: Location where goods are delivered for packing into containers or where goods picked up after containers are stripped for local delivery.

Cordon
: The boundary of the area being studied.

Cordon counts
: A count of all vehicles entering or leaving a distinct installation or cordon area during a period of time (e.g., a typical day).

Cordon stations
: Locations on each street crossing the cordon where vehicles are counted and classified.

Desire line
: A straight line between the point of origin and point of destination of a trip without regard to routes of travel (used in connection with origin-destination studies).

85th percentile speed
: That speed at or below which 85 percent of vehicles travel.

Full trailer
: A truck trailer designed for being drawn by a truck tractor and so constructed that practically all its weight and load rests upon its own wheels.

Generated traffic
: Motor vehicle (e.g., trucks) trips, other than public transit, that are made because of the existence of a new facility (e.g., MCT). Sometimes called induced traffic.

Headway
: Distance measured front to front, between consecutive vehicles. Time interval between passages of consecutive vehicles, measured from head to head, moving in the same direction as they pass a given point.

Interchange
: A system of interconnecting roadways with grade separation providing

for the interchange of traffic between two or more roadways on different levels.

Intersection count
A count of vehicles entering an intersection on each leg classified by turning and straight movements and also by types of vehicles.

Local authorities
County, municipal, and other local board or body having authority to enact ordinances relating to traffic under the constitution and laws of the state.

Marine Container Terminal (MCT)
A freight terminal at the water's edge where marine containers are loaded onto and unloaded off of a vessel. A more detailed description appears within this manual.

Operating speed
The highest overall speed exclusive of stops at which a driver can travel on a given highway under prevailing conditions without at any time exceeding the design speed. Sometimes called overall travel speed, average speed, optimum speed.

Operational delay
The delay caused by interference between components of traffic. The difference between travel times over a route during extremely low and high traffic volumes.

Origin-Destination study (O-D)
A study of the origins and destinations of trips, usually of trips within, passing through, or into and out of a distinctive area or facility.

Parking bay
The parking area immediately adjacent to the margin of a roadway and abutting thereon, provided by especially widening the street.

Parking facility
Parking spaces provided off of the main roadway.

Parking lane
A strip of roadway or parking facility where vehicles may be legally parked but which would otherwise be available to moving traffic.

Peak hour traffic
That period during the day when maximum traffic volume is experienced.

Percent of grade
The slope in the longitudinal direction of the road expressed in the number of units of change in elevation per 100 units of horizontal distance.

Private roadways
Similar to public roadways except that public use is at the discretion of the owner.

Public roadways
The entire width between property lines in which any part is open for use of the public for vehicular traffic as a matter of right or custom.

Ramp
A turning roadway at an interchange for travel between intersection legs.

Roadway capacity
The maximum number of vehicles that can pass a given point on a lane or roadway during one hour, under prevailing roadway and traffic conditions.

Semitrailer
A truck trailer without motive power designed for being drawn by a truck tractor and so constructed that some part of its load rests upon and is carried by the towing vehicle.

Signal Cycle
Time required for a complete sequence of traffic signal intervals.

Signalhead
The assembly containing one or more signals controlling vehicular travel in one or more directions.

T interchange
An interchange with three connections with one or more grade separations. Often provided to facilitate entrance and exit of one leg when two of the other three legs form a through road. (See diagram.)

Ten (10) mph pace
The 10 mph speed range containing the largest percentage of vehicles in a sample of spot speeds.

TOFC/COFC
Trailer on Flat Car (and) Container on Flat Car: methods of moving trailers or containers by railroad.

Trip
A single vehicle movement with either the origin or destination being (in this case) the MCT.

Trip end
The origin or destination of a trip.

Trip ratio
The ratio of the number of trips or trip ends to a unit measurement such as acre, persons, number of containers, etc.

Truck
Motor vehicle designed, used or maintained for transportation of goods and property.

Truck combination
A truck tractor and a semitrailer, either with or without a full trailer.

Truck tractor
A motor vehicle designed and used primarily for drawing other vehicles such as semitrailers and trailers.

Volume
The number of vehicles passing a given point during a specified period of time.

APPENDIX

FORMS FOR MCT

TRAFFIC STUDIES

TRAFFIC COUNTING

INSTRUCTIONS

Date_____ Location_____

Time_____ Count_____

What to count: Unless otherwise directed the vehicles entering the intersection are the only ones counted. Each entering vehicle is tabulated, first according to the direction it is going, and then as to whether it turns right, goes straight thru, or turns left. U turns are considered as left turns.

Tally sheet: The tally sheet has four divisions to record the vehicles entering the intersection from each of at least four directions. When ready to count orient the tally sheet so that these divisions are aligned exactly as the entering stream of traffic. Vehicle movements in the direction of the arrows will actually lie in the true directions.

Use of sheet: Use the customary tally system of making four vertical marks and a fifth one diagonally thru the four. Each page is to be used for the desired time period. Record weather conditions at beginning and end of count and at other times when changes occur.

Equipment:

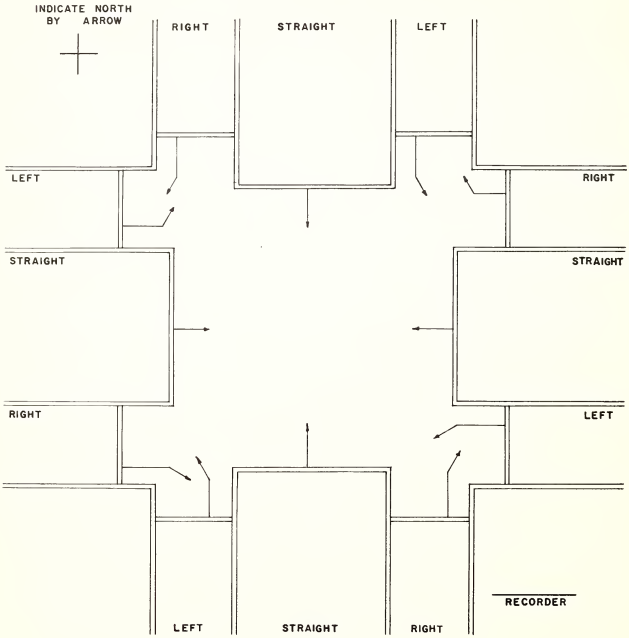
1. A watch.
2. Two or more pencils.
3. A good eraser.
4. A knife or pencil sharpener.

VEHICLE VOLUME

FIELD SHEET

DATE _____ LOCATION _____

WEATHER _____ ROAD SURFACE CONDITIONS _____ TIME FROM _____ TO _____



Form B-1 Vehicle volume summary sheet

LOCATION_____ DATE_____

WEATHER _____ROAD SURFACE CONDITION_____

Time starts M	From north on _____St.			From south on _____St.			From west on _____St.			From east on _____St.			Half hour total
	L	S	R	L	S	R	L	S	R	L	S	R	
0700–0730													
0730–0800													
0800–0830													
0830–0900													
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2300–2330													
2330–2400													
Total													
Total													

Compiled by_____

R—Right turn.
L—Left turn.
S—Straight ahead.

Form B-2 Vehicle Volume Summary Sheet

TRIP GENERATION STUDY TRAFFIC COUNT DATA
Manual Count

Name_____ Study_____

Location_____ Day_____ Date_____ Direction_____

Type \ Hour	AM 6-7	7-8	8-9	9-10	10-11	11-12	PM 12-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	Total
Autos																	
Pick-ups																	
Auto/Trailers																	
Occupants																	
Buses																	
Trucks 2-axle																	
No. Containers (L, S)																	
Trucks 3-axle																	
No. Containers (L, S)																	
Trucks 4-axle																	
No. Containers (L,S)																	
Trucks 5-axle (or more)																	
No. Containers (L, S)																	

Total_____

Size of containers: L = large; S = small

VEHICLE VOLUME

GRAPHIC SUMMARY SHEET

LOCATION _____ DATE _____

TIME _____ HOURS FROM

_____ TO _____

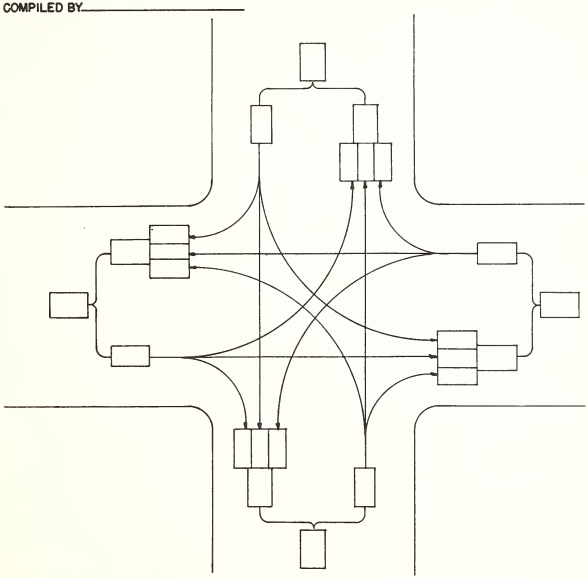
_____ TO _____

WEATHER _____

ROAD SURFACE CONDITION _____

COMPILED BY _____

INDICATE NORTH BY ARROW



REMARKS & RECOMMENDATIONS _____

Form D Container Truck Travel Log

DRIVER_____ Number axles_____

TRUCK LICENSE_____ Ownership_____

DATE_____ Garage address_____

IDENTITY OF MCT

TIME OF ARRIVAL AT MCT_____

TIME OF DEPARTURE FROM MCT_____

ODOMETER READING_____

(CIRCLE ONE) FULL CONTAINER | EMPTY CONTAINER | EMPTY TRAILER | NO TRAILER

NUMBER OF TRAILERS_____

TO THIS STOP

Address_____

_____

Reason for stopping (see code)_____

Time of arrival_____

Time of departure_____

Odometer reading_____

(CIRCLE ONE) FULL CONTAINER | EMPTY CONTAINER | EMPTY TRAILER | NO TRAILER

NUMBER OF TRAILERS_____

TO THIS STOP

Address_____

_____

Reason for stopping (see code)_____

Time of arrival_____

Time of departure_____

Odometer reading_____

(CIRCLE ONE) FULL CONTAINER | EMPTY CONTAINER | EMPTY TRAILER | NO TRAILER

NUMBER OF TRAILERS_____

STOP PURPOSE

Code

01	Pickup Load
02	Deliver Load
03	To Garage or Base of Operations
04	Service/Repair
05	Personal Business
06	Meal
07	Home
08	Other

Form E Field sheet, speed-delay study

ROUTE_____ DIRECTION_____ TRIP NO._____

TRIP STARTED_____ A.M. P.M. at _____ (Location) _____ (Mileage)

TRIP ENDED_____ A.M. P.M. at _____ (Location) _____ (Mileage)

Continuous time reading (Minutes seconds)	Check block for begin and end of Stop	Odometer reading (miles & tenths)	Location or landmark	Cause for stop or slow

DATE_____ WEATHER_____ DISTANCE_____

OVERALL TIME_____ STOPPED TIME_____

Form F Parking usage survey field sheet

Location North side of Provost Street

From 1st Avenue to 2nd Avenue

Weather Clear Time: From 0800 to 1000

Record Starting Time of Each Roundtrip at Top of each Column Below

0800	0815	0830	0845	0900	0915	0930	0945
001	✓	✓	E	E	E	677-843	✓
684	✓	✓	✓	✓	✓	E	E
453	8963	✓	✓	E	4285	✓	✓
222	E	E	548-270	✓	✓	E	E

Date 5 Oct Recorder Gifkins